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Primary Examiner — Rodney H Bonck

Assistant Examiner — Lillian Nguyen

(74) *Attorney, Agent, or Firm* — Kathryn A. Wamer; Kevin L. Parks

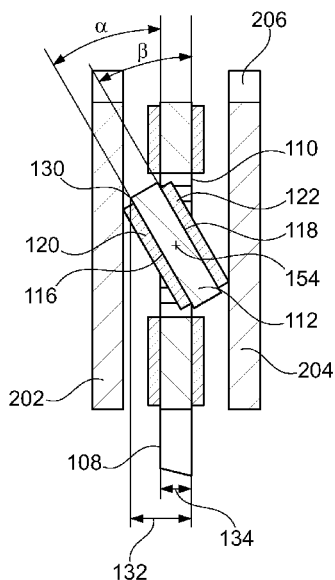
Related U.S. Application Data

(57) **ABSTRACT**

A clutch plate includes an annular body and an integral resilient portion connected to the annular body by a first circumferentially extending tab. The annular body has inner and outer diameters and first and second parallel surfaces extending therebetween. The resilient portion has third and fourth parallel surfaces extending at respective acute angles to the first and second parallel surfaces. In some example embodiments, the clutch plate includes a wet friction material affixed to the first and third surfaces. In an example embodiment, the clutch plate has a wet friction material affixed to the second and fourth surfaces. In an example embodiment, the clutch plate has first and second circumferential slots respectively disposed radially inside and outside of the first circumferentially extending tab.

17 Claims, 3 Drawing Sheets

(58) **Field of Classification Search**
CPC . F16D 2013/642; F16D 13/68; F16D 13/648;
F16D 69/0408; F16D 13/683
USPC 92/107 C, 70.28, 85.4, 52.3
See application file for complete search history.



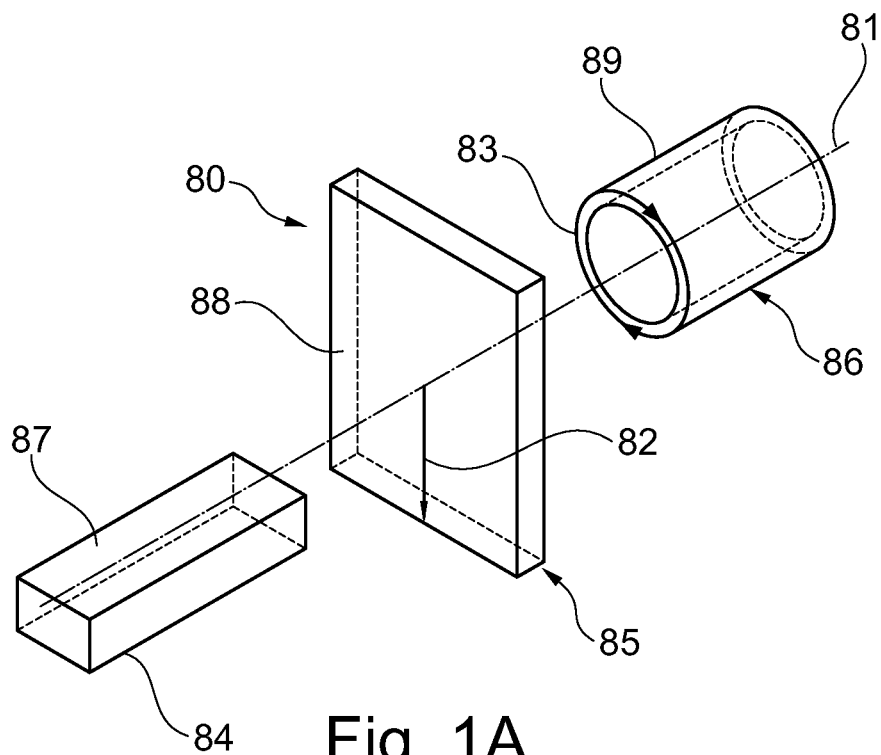


Fig. 1A

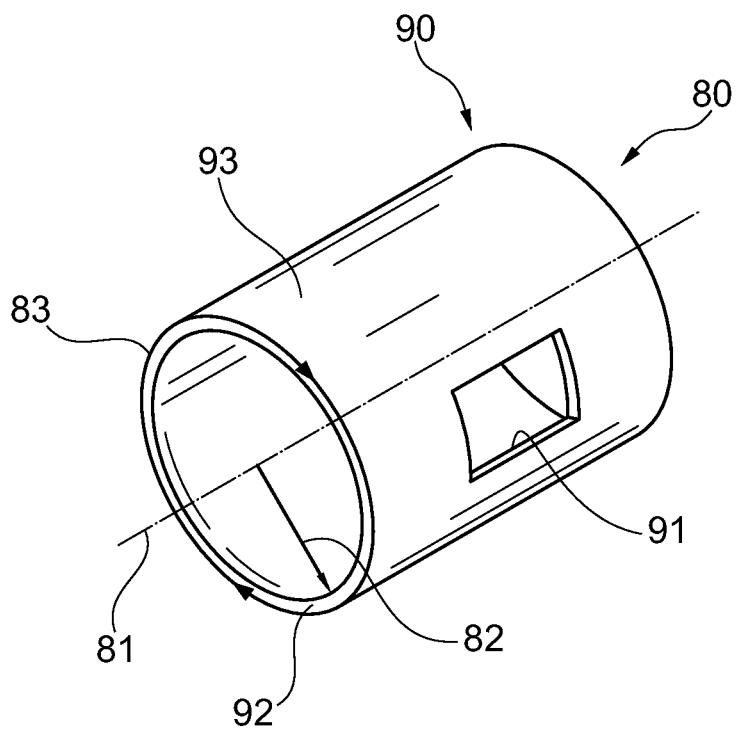


Fig. 1B

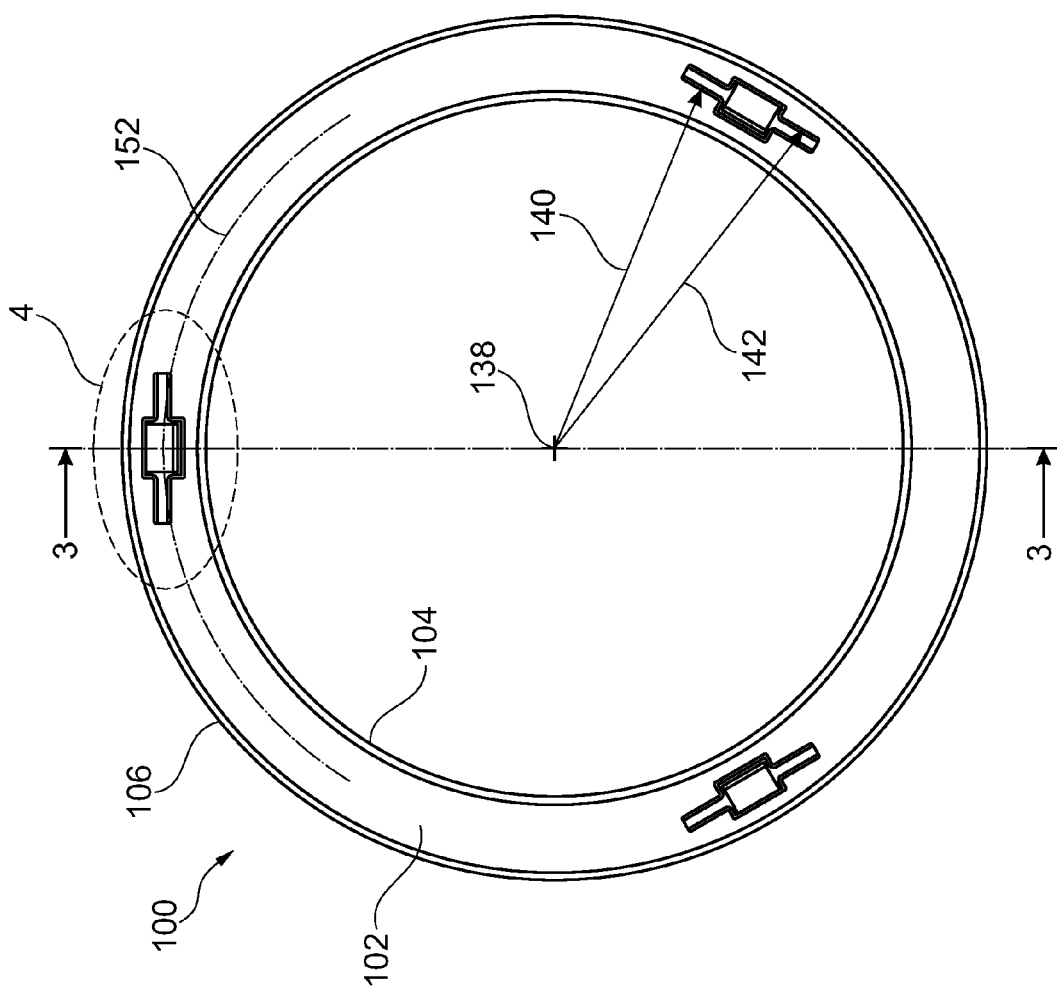


Fig. 2

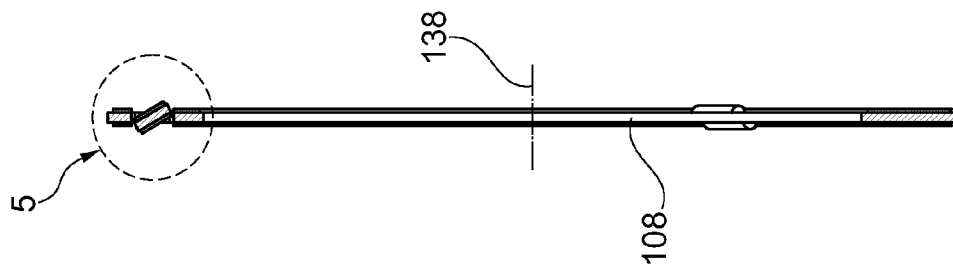


Fig. 3

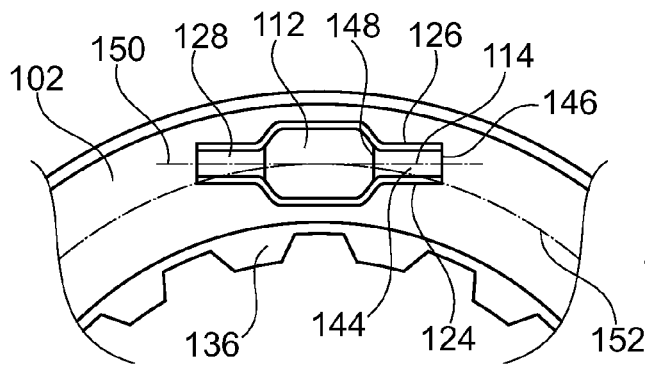


Fig. 4

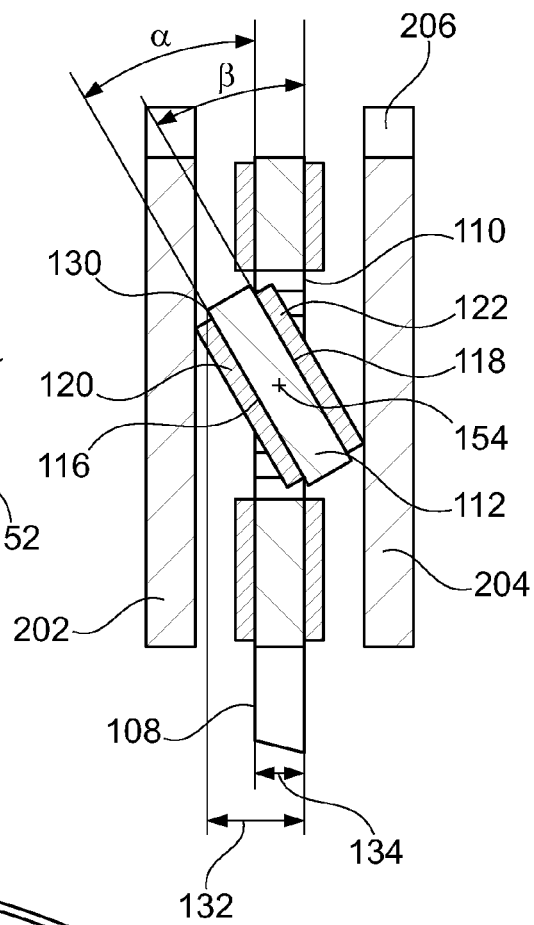


Fig. 5

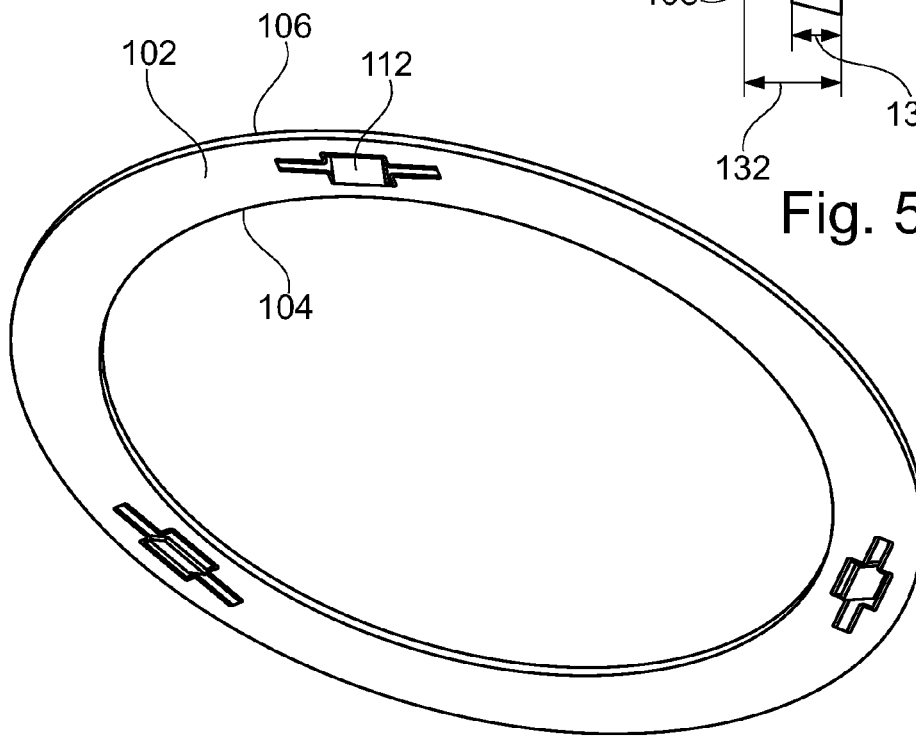


Fig. 6

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REDUCED DRAG CLUTCH PLATE**FIELD**

The invention relates generally to a clutch plate, and more specifically to a clutch plate with an integral drag reducing element.

BACKGROUND

Clutch plates are known. One example is shown in commonly-assigned U.S. patent application publication No. 2011/0000758 for a reduced drag clutch plate including a resilient drag reducing element with a formed portion disposed radially between friction ring inner and outer circumferences.

BRIEF SUMMARY

Example aspects broadly comprise a clutch plate including an annular body and an integral resilient portion connected to the annular body by a first circumferentially extending tab. The annular body has inner and outer diameters and first and second parallel surfaces extending therebetween. The resilient portion has third and fourth parallel surfaces extending at respective acute angles to the first and second parallel surfaces. In some example embodiments, the clutch plate includes a wet friction material affixed to the first and third surfaces. In an example embodiment, the clutch plate has a wet friction material affixed to the second and fourth surfaces. In an example embodiment, the clutch plate has first and second circumferential slots respectively disposed radially inside and outside of the first circumferentially extending tab.

In some example embodiments, the clutch plate includes a second circumferentially extending tab. The resilient portion is disposed circumferentially between the first and second circumferentially extending tabs. In an example embodiment, the clutch plate has first and second circumferential slots respectively disposed radially inside and outside of the first circumferentially extending tab, and third and fourth circumferential slots respectively disposed radially inside and outside of the second circumferentially extending tab. In some example embodiments, the resilient portion third surface includes an edge, and an axial height of the edge is greater than a thickness of the annular body when measured from the second surface. In an example embodiment, the resilient portion is arranged to pivot with respect to the annular body such that the axial height of the edge is aligned with a plane formed by the first annular surface.

Other example aspects broadly comprise a clutch pack including first and second pressure plates and the clutch plate disposed therebetween. In an example embodiment, one of the first or second pressure plates, or the clutch plate, includes a radially outer spline for engaging a first clutch carrier, and the other of the first or second pressure plates, or the clutch plate, includes a radially inner spline for engaging a second clutch carrier. In an example embodiment, the resilient portion is arranged to be deflectable by the first and second pressure plates.

Other example aspects broadly comprise a clutch plate including a ring-shaped body portion, first and second slots, a connector portion, and a pivotable portion. The body portion has a first annular surface and includes a central axis extending orthogonal to the annular surface. The first slot extends from the first annular surface through the body portion in a circumferential direction at a varying radius when measured from the central axis. The second slot extends from the first

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annular surface through the body portion in a circumferential direction at a varying radius when measured from the central axis. The connector portion is disposed radially between the two slots at a first circumferential position. The pivotable portion is disposed radially between the two slots at a second circumferential position, offset from the first circumferential position, and including a planar surface extending at an acute angle with respect to the first annular surface.

In an example embodiment, the radii of the slots is closest together at the first circumferential position, and the radii of the slots is farthest apart at the second circumferential position. In an example embodiment, the clutch plate includes a wet friction material affixed to the first annular surface and the pivotable portion planar surface. In an example embodiment, an inner circumference or an outer circumference of the annular portion includes a spline arranged for driving engagement with a clutch carrier.

Other example embodiment broadly comprise a clutch plate including first, second, and third surfaces. The first surface is a ring-shaped surface parallel to a first plane. The second surface is integral with the first surface and parallel to a second plane, non-parallel to the first plane. The third surface is a non-planar connector surface extending between the first and second surfaces. The third surface includes a first edge, shared with the first surface and parallel to the first plane, and a second edge, shared with the second surface and parallel to the second plane. In an example embodiment, the clutch plate includes a wet friction material affixed to the first and second surfaces. In an example embodiment, the clutch plate includes a fourth surface, parallel to and offset from the second surface by a first thickness and a central axis orthogonal to the first plane. The second and fourth surfaces are rotated relative to the first surface about an axis tangent to a circle with a center point on the central axis and passing through a point midway between the second and fourth surfaces.

BRIEF DESCRIPTION OF THE DRAWINGS

The nature and mode of operation of the present invention will now be more fully described in the following detailed description taken with the accompanying drawing figures, in which:

FIG. 1A is a perspective view of a cylindrical coordinate system demonstrating spatial terminology used in the present application;

FIG. 1B is a perspective view of an object in the cylindrical coordinate system of FIG. 1A demonstrating spatial terminology used in the present application;

FIG. 2 is a front view of a clutch plate according to an example aspect;

FIG. 3 is a section view of the clutch plate of FIG. 2 taken generally along line 3-3 in FIG. 2;

FIG. 4 is a detail view of encircled region 4 in FIG. 2;

FIG. 5 is a detail view of encircled region 5 in FIG. 3;

FIG. 6 is a perspective view of the clutch plate of FIG. 2.

DETAILED DESCRIPTION

At the outset, it should be appreciated that like drawing numbers appearing in different drawing views identify identical, or functionally similar, structural elements. Furthermore, it is understood that this invention is not limited only to the particular embodiments, methodology, materials and modifications described herein, and as such may, of course, vary. It is also understood that the terminology used herein is for the purpose of describing particular aspects only, and is

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not intended to limit the scope of the present invention, which is limited only by the appended claims.

Unless defined otherwise, all technical and scientific terms used herein have the same meaning as commonly understood to one of ordinary skill in the art to which this invention belongs. Although any methods, devices or materials similar or equivalent to those described herein can be used in the practice or testing of the invention, the following example methods, devices, and materials are now described.

FIG. 1A is a perspective view of cylindrical coordinate system **80** demonstrating spatial terminology used in the present application. The present invention is at least partially described within the context of a cylindrical coordinate system. System **80** has a longitudinal axis **81**, used as the reference for the directional and spatial terms that follow. The adjectives “axial,” “radial,” and “circumferential” are with respect to an orientation parallel to axis **81**, radius **82** (which is orthogonal to axis **81**), and circumference **83**, respectively. The adjectives “axial,” “radial” and “circumferential” also are regarding orientation parallel to respective planes. To clarify the disposition of the various planes, objects **84**, **85**, and **86** are used. Surface **87** of object **84** forms an axial plane. That is, axis **81** forms a line along the surface. Surface **88** of object **85** forms a radial plane. That is, radius **82** forms a line along the surface. Surface **89** of object **86** forms a circumferential plane. That is, circumference **83** forms a line along the surface. As a further example, axial movement or disposition is parallel to axis **81**, radial movement or disposition is parallel to radius **82**, and circumferential movement or disposition is parallel to circumference **83**. Rotation is with respect to axis **81**.

The adverbs “axially,” “radially,” and “circumferentially” are with respect to an orientation parallel to axis **81**, radius **82**, or circumference **83**, respectively. The adverbs “axially,” “radially,” and “circumferentially” also are regarding orientation parallel to respective planes.

FIG. 1B is a perspective view of object **90** in cylindrical coordinate system **80** of FIG. 1A demonstrating spatial terminology used in the present application. Cylindrical object **90** is representative of a cylindrical object in a cylindrical coordinate system and is not intended to limit the present invention in any manner. Object **90** includes axial surface **91**, radial surface **92**, and circumferential surface **93**. Surface **91** is part of an axial plane, surface **92** is part of a radial plane, and surface **93** is part of a circumferential plane.

The following description is made with reference to FIGS. 2-6. FIG. 2 is a front view of clutch plate **100** according to an example aspect. FIG. 3 is a section view of clutch plate **100** of FIG. 2 taken generally along line 3-3 in FIG. 2. FIG. 4 is a detail view of encircled region **4** in FIG. 2. FIG. 5 is a detail view of encircled region **5** in FIG. 3. FIG. 6 is a perspective view of clutch plate **100** of FIG. 2. Clutch plate **100** includes annular body, or ring-shaped body portion, **102** with inner and outer diameters, **104** and **106**, respectively, and respective parallel surfaces **108** and **110**, extending therebetween. Plate **100** also includes integral resilient portion **112** connected to annular body **102** by circumferentially extending tab **114**. Integral means that the body and the resilient portion are formed from a same piece of material. Portion **112** includes respective parallel surfaces **116** and **118** extending at respective acute angles α and β to surfaces **108** and **110**. Clutch plate **100** includes wet friction material **120** affixed to surfaces **108** and **116**, and friction material **122** affixed to surfaces **110** and **118**. Although plate **100** is shown with friction material affixed to both sides, other embodiments may include friction material on only one side or have no friction material at all.

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Clutch plate **100** includes circumferential slots **124** and **126** respectively disposed radially inside and outside of circumferentially extending tab **114**. Clutch plate **100** also includes circumferentially extending tab **128**. As best seen in FIG. 4, resilient portion **112** is disposed circumferentially between circumferentially extending tabs **114** and **128**. Surface **116** includes edge **130**. Height **132** of edge **130** is greater than thickness **134** of body **102** measured from surface **110**. Portion **112** is arranged to pivot with respect to annular body **102** such that axial height **132** of edge **130** is aligned with a plane formed by the annular surface **108**. In other words, because portion **112** is formed of a same piece of material as body **102**, portion **112** is pivotable to lie coplanar with the annular body such that the portion and the body form a flat surface.

As shown in FIG. 5, clutch pack **200** includes pressure plates **202** and **204**, and clutch plate **100**. Pressure plates **202** and **204** include radially outer spline **206** for engaging a clutch carrier (not shown) and clutch plate **100** includes radially inner spline **136** for engaging a clutch carrier (not shown). Portion **112** is arranged to be deflectable by the pressure plates **202** and **204**. For example, portion **112** axially displaces the pressure plates away from the clutch plate to reduce viscous drag from an oil bath in which the clutch pack is installed when the pressure plates and the clutch plate are rotating at different speeds. But when the clutch is engaged and axial force is applied to the pressure plates to clamp the clutch plate, the resilient portion is easily deflected so that the pressure plates tightly clamp against the clutch plate friction material as in a conventional clutch plate.

Central axis **138** extends orthogonal to surface **108**. Slot **124** extends from annular surface **108** through body portion **102** in a circumferential direction at varying radius **140** when measured from central axis **138**. Slot **126** extends from annular surface **108** through body portion **102** in a circumferential direction at varying radius **142** when measured from central axis **138**. Connector portion **114** is disposed radially between the two slots at a first circumferential position and pivotable portion **112** is disposed radially between the two slots at a second circumferential position, offset from the first circumferential position. Radial distances, or radii, **140** and **142** is closest together at the first circumferential position, and farthest apart at the second circumferential position. That is, a radial width of portion **114** is less than a radial width of pivotable portion **112**.

Circumferentially extending tab **114** includes connector surface **144** with edge **146** shared with surface **108**, and edge **148** shared with surface **116**. Portion **112**, and surfaces **116** and **118**, are rotated relative to surface **108** about axis **150** tangent to circle **152** with a center point on central axis **138** and passing through point **152** midway between surfaces **116** and **118**. Although plate **100** is shown with three pivotable portions **112**, other numbers are possible. Generally, at least three portions **112** are preferred.

Of course, changes and modifications to the above examples of the invention should be readily apparent to those having ordinary skill in the art, without departing from the spirit or scope of the invention as claimed. Although the invention is described by reference to specific preferred and/or example embodiments, it is clear that variations can be made without departing from the scope or spirit of the invention as claimed.

I claim:

1. A clutch plate comprising:
an annular body with inner and outer diameters and first and second parallel surfaces extending therebetween;

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an integral resilient portion connected to the annular body by a first circumferentially extending tab and including third and fourth parallel surfaces extending at respective acute angles to the first and second parallel surfaces; and,

the resilient portion third surface includes an edge; and, an axial height of the edge is greater than a thickness of the annular body when measured from the second surface.

2. The clutch plate of claim 1 further comprising a wet friction material affixed to the first and third surfaces.

3. The clutch plate of claim 2 further comprising a wet friction material affixed to the second and fourth surfaces.

4. The clutch plate of claim 1 further comprising first and second circumferential slots respectively disposed radially inside and outside of the first circumferentially extending tab.

5. The clutch plate of claim 1 further comprising a second circumferentially extending tab, wherein the resilient portion is disposed circumferentially between the first and second circumferentially extending tabs.

6. The clutch plate of claim 5 further comprising: first and second circumferential slots respectively disposed radially inside and outside of the first circumferentially extending tab; and,

third and fourth circumferential slots respectively disposed radially inside and outside of the second circumferentially extending tab.

7. The clutch plate of claim 1 wherein the resilient portion is arranged to pivot with respect to the annular body such that the axial height of the edge is aligned with a plane formed by the first parallel surface.

8. A clutch pack comprising: first and second pressure plates; and, the clutch plate of claim 1 disposed therebetween.

9. The clutch pack of claim 8 wherein: one of the first or second pressure plates, or the clutch plate, includes a radially outer spline for engaging a first clutch carrier; and,

the other of the first or second pressure plates, or the clutch plate, includes a radially inner spline for engaging a second clutch carrier.

10. The clutch pack of claim 8 wherein the resilient portion is arranged to be deflectable by the first and second pressure plates.

11. A clutch plate comprising: a ring-shaped body portion with a first annular surface and including a central axis extending orthogonal to the annular surface;

a first slot extending from the first annular surface through the body portion in a circumferential direction at a varying radius when measured from the central axis;

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a second slot extending from the first annular surface through the body portion in a circumferential direction at a varying radius when measured from the central axis; first and second connector portions disposed radially between the two slots at first and second circumferential positions; and,

a pivotable portion disposed radially between the two slots at a third circumferential position, disposed between the first and second circumferential positions, and including a planar surface extending at an acute angle with respect to the first annular surface.

12. The clutch plate of claim 11 wherein the radii of the slots is closest together at the first and second circumferential positions, and the radii of the slots is farthest apart at the third circumferential position.

13. The clutch plate of claim 11 further comprising a wet friction material affixed to the first annular surface and the pivotable portion planar surface.

14. The clutch plate of claim 11 wherein an inner circumference or an outer circumference of the annular portion includes a spline arranged for driving engagement with a clutch carrier.

15. A clutch plate comprising:

first and second, ring-shaped, surfaces, having a first thickness therebetween, parallel to a first plane and including a central axis orthogonal to the first plane;

a third surface, integral with the first surface and parallel to a second plane, non-parallel to the first plane; the third surface including a first edge;

a fourth, non-planar, connector surface extending between the first and third surfaces and including a second edge, shared with the first surface and parallel to the first plane, and a third edge, shared with the third surface and parallel to the second plane;

the third surface first edge having an axial height greater than the first thickness when measured from the second surface.

16. The clutch plate of claim 15 further comprising a wet friction material affixed to the first and third surfaces.

17. The clutch plate of claim 15 wherein:

the clutch plate further comprises: a fifth surface, parallel to and offset from the third surface by a second thickness; and,

the third and fifth surfaces are rotated relative to the first surface about an axis tangent to a circle with a center point on the central axis and passing through a point midway between the third and fifth surfaces.

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